Shoreline Protection Technical Memorandum Installation Restoration Site 7 Parcel B

Hunters Point Shipyard San Francisco, California

April 3, 2009

Prepared for:
Base Realignment and Closure
Program Management Office West
San Diego, California

Prepared by:
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Prepared under:
Naval Facilities Engineering Command
Contract Number N62473-04-D-3213
Contract Task Order 0019

CHAD-3213-0019-0045

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APR 3 2009

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Dear BCT members:

Enclosure (1) is the Shoreline Protection Technical Memorandum for Installation Restoration Site 7, Parcel B, Hunters Point Shipyard, San Francisco, California, April 3, 2009. This technical memorandum was prepared in response to requests from regulatory agencies and members of the public to evaluate possible shoreline stabilization options that could provide or preserve beach and natural vegetation along the shoreline, which would not occur with the current revetment option selected in the amended record of decision. This document provides additional information and supplements the evaluation of alternatives already provided in previous documents. This is a final document and is provided for informational purposes only.

If you should you have any concerns with this matter, please contact Mr. Keith Forman, at (619) 532-0913.

Sincerely,

KEITH FORMAN
BRAC Environmental Coordinator
By direction of the Director

Enclosure: 1. Shoreline Protection Technical Memorandum for Installation Restoration Site 7, Parcel B, Hunters Point Shipyard, San Francisco, California, April 3, 2009

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Parcel B

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Prepared for:

DEPARTMENT OF THE NAVY

REVIEW AND APPROVAL

Project Manager: Timothy E. Mower — Tim Mower, ChaduxTt — Date: April 3, 2009

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ACRONYMS AND ABBREVIATIONS

COC	Chemical of concern
DBR	Design basis report
HHRA	Human health risk assessment
HPS	Hunters Point Shipyard
IR	Installation Restoration
MHHW	Mean higher high water
MLLW	Mean lower low water
msl	Mean sea level
NOAA	National Oceanic and Atmospheric Administration
O&M	Operation and maintenance
PAH	Polycyclic aromatic hydrocarbon
PCB	Polychlorinated biphenyl
RD	Remedial design
ROD	Record of decision
SLERA	Screening-level ecological risk assessment
SVOC	Semivolatile organic compound
TCRA	Time-critical removal action
TMSRA	Technical Memorandum in Support of a Record of Decision Amendment
VOC	Volatile organic compound

EXECUTIVE SUMMARY

This shoreline protection technical memorandum compares three potential protection options for the on-shore and off-shore portion of Installation Restoration (IR) Program Site 7 at Parcel B at Hunters Point Shipyard (HPS) in San Francisco, California. The three options summarized are a shoreline revetment; a hybrid living shoreline and breakwater; and an above-shore sheet pile barrier. This report develops the general basis of design for the options and assesses their overall effectiveness in addressing the remedial objectives. The evaluations in this report supplement those presented in the Technical Memorandum in Support of a Record of Decision (ROD) Amendment (ChaduxTt 2007) and support selection of the shoreline revetment as part of the amended remedial action chosen in the amended ROD (ChaduxTt 2009a). This technical memorandum was prepared in response to requests from regulatory agencies and members of the public to evaluate possible shoreline stabilization options that could provide or preserve beach and natural vegetation along the shoreline, which are not provided in the current revetment option (ChaduxTt 2009b). The three shoreline protection options evaluated in this technical memorandum are briefly discussed below.

- **On-shore revetment**: this option is a blanket of riprap that covers and protects the shoreline, resting on specially designed filters to prevent erosion of fine material while allowing transfer of water.
- **Hybrid living shoreline and breakwater**: this option would include regrading along the shoreline bank and planting native species along the shoreline to promote habitat restoration and reduce erosion. This option would include construction of an off-shore breakwater to limit incoming wave energy.
- **Above-shore sheet pile barrier**: this option is a solid sheet pile wall of corrosion-resistant materials extending into the subsurface to prevent lateral contact with the contaminated soil on the land portion of the site. The sheet pile wall would as a secondary benefit provide erosion control and containment of the land portion of the site in the event of a catastrophic loss of the existing shoreline.

Chemicals of concern (COC) have been identified in shoreline sediment extending to the off-shore boundary of IR Site 7 that pose potential risks to both human and ecological receptors. Furthermore, radionuclides may be present in this sediment. The remedy for the shoreline must prevent exposure to the COCs and prevent off-site migration to protect human health and ecological receptors. This consideration was the primary selection criterion used to compare the three remedial options, along with secondary criteria such as habitat impact, operation and maintenance, intrusiveness, and capital costs.

The primary disadvantages of the hybrid living shoreline and breakwater are that the existing conditions at the site are not well suited for the establishment of vegetation, and ongoing, intensive maintenance would be required for the remedy to remain protective.

The primary disadvantage to the above-shore sheet pile barrier is that it would not address exposure to COCs in the shoreline sediment and the potential for off-site migration of sediment because it is located upland of the shoreline.

The revetment option would fully encapsulate and stabilize the shoreline and would best meet the remedial objectives of preventing exposure and off-site migration of COCs.

1.0 INTRODUCTION

The Navy is implementing the remedy identified in the amended record of decision (ROD) for Hunters Point Shipyard (HPS) Parcel B (ChaduxTt 2009a) at Installation Restoration (IR) Program Sites 7 and 18. This shoreline protection technical memorandum provides generalized technical descriptions of three options for protection of the IR Site 7 shoreline portion of the remedy as a supplement to the amended ROD and the design basis report (DBR) for both IR Sites 7 and 18 (ChaduxTt 2009b). The evaluations in this report also supplement those presented in the Technical Memorandum in Support of a Record of Decision Amendment (TMSRA) (ChaduxTt 2007). This technical memorandum was prepared in response to requests from regulatory agencies and members of the public to evaluate possible shoreline stabilization options that could provide or preserve beach and natural vegetation along the shoreline, which are not provided in the current revetment option (ChaduxTt 2009b). This report presents information to support selection of the shoreline revetment as the remedy for the shoreline.

The three shoreline protection options included in this report are a riprap revetment, a hybrid living shoreline and breakwater, and an above-shore sheet pile barrier. Each of these three options offers varying degrees of shoreline erosion control, prevention of releases of pollutants, protection of human and ecological receptor contact with chemicals of concern (COC) in shoreline soil and sediment, operation and maintenance needs, and preservation of the shoreline habitat and beach. This report presents comparative costs and evaluations of the constructability of the three options. An all-encompassing study of each of these options and other options is beyond the scope of this report; however, this report provides an overall generalized study of the advantages and disadvantages of the options available.

Figures referenced in this report follow Section 7.0. This report contains representative drawings to illustrate the concepts incorporated in the shoreline protection remedy options and their general layout.

2.0 BACKGROUND

The following sections describe the facility, location, nature and extent of contamination, and general history of IR Site 7 and adjacent IR Site 18. Refer to the amended ROD for a more complete description of the site background (ChaduxTt 2009a).

2.1 SITE DESCRIPTION

HPS is located in the City and County of San Francisco, California and includes 866 acres (420 acres on land and 446 acres under water in San Francisco Bay) (Figure 1). HPS is divided into 11 parcels: B, C, D-1, D-2, E, E-2, F, G, UC-1, UC-2 and UC-3. Parcel B includes 59 acres on the northern side of HPS (Figure 2). IR Site 7 consists of 9 acres on the western side of Parcel B. IR Site 7 includes a shoreline of approximately 950 feet along San Francisco Bay; this shoreline is the focus of this report. Portions of IR Site 7 extend into San Francisco Bay where Parcel B adjoins the offshore Parcel F.

The shoreline is subject to tidal fluctuations, wave and wind impacts originating from off shore, and other issues that do not affect the landward portions of IR Site 7. The mean higher high water (MHHW) and mean lower low water (MLLW) tides affecting the shoreline are +3.43 feet mean sea level (msl) and -3.43 feet msl (NOAA National Ocean Service 2003). The slopes of the upper portions of the shoreline and bank are approximately between 1 vertical and 3 horizontal (1V:3H) to 1V:8H along the bank and 1V:10H to 1V:20H off shore from the site (Figures 3, 4, and 5).

2.2 HISTORY

The Navy used HPS starting around 1939 for shipbuilding, repair, and maintenance. However, the Navy continued to operate carrier overhaul and ship maintenance and repair facilities through the 1960s. Other significant activities after World War II included decontamination of ships used during atomic weapons testing in the South Pacific and operation of the Naval Radiological Defense Laboratory from the late 1940s until 1969. Decontamination of ships associated with atomic weapons testing began in September 1946 and continued through 1951. HPS was deactivated in 1974 and remained largely unused until 1976. Between 1976 and 1986, the Navy leased most of HPS to Triple A Machine Shop, Inc., a private ship repair company. The Navy resumed occupancy of HPS in 1987.

Small portions of the area that are now identified as IR Sites 7 and 18 already existed when the property was purchased by the Navy. The Navy significantly expanded the original area during development of the shipyard to its present configuration; the majority of the land area at IR Sites 7 and 18 was created by depositing fill into the bay. The expansion of the current location of IR Sites 7 and 18 was primarily through the use of engineered fill materials that were derived by quarrying the local bedrock. Some of the fill included construction debris. Although most of the expansion of Parcel B had been completed before 1946, much of the land area of IR Sites 7 and 18 was created during the 1950s and 1960s.

2.3 NATURE AND EXTENT OF CONTAMINATION

Results of previous investigations indicated chemicals at IR Site 7 pose a potential risk to human health and the environment based on current and reasonably anticipated future land uses. The human health risk assessment (HHRA) identified the following COCs in soil or sediment as posing risk to human health: metals, semivolatile organic compounds (SVOC), pesticides, polychlorinated biphenyls (PCB), and radionuclides. The screening-level ecological risk assessment (SLERA) identified metals, pesticides, PCBs, and polycyclic aromatic hydrocarbons (PAH) as posing risk to ecological receptors along the shoreline.

Figure 6 shows the distribution of the samples collected along the shoreline and where chemicals detected in these samples exceed remediation goals for human health (recreational exposure) or ecological receptors established in the amended ROD (ChaduxTt 2009a).

Radionuclides may also be present in the sediment along the shoreline of IR Site 7. The Historical Radiological Assessment (NAVSEA 2004) identified potential radionuclides of concern at IR Site 7, including strontium-90, cesium-137, radium-226, and plutonium-239. The area at IR Site 7 was located close to Navy activities that involved low-level radioactive material and, consequently, certain types of radioactive materials (such as sandblast grit used in decontamination of ships that participated in atomic weapons testing, and radioluminescent dials and gauges) may have been left in place at IR Site 7.

3.0 OVERALL DESIGN APPROACH

Evaluation of suitable shoreline protection depends on identifying key engineering, aesthetic, environmental, and economic factors, including:

- Prevention of contaminant migration from IR Site 7
- Tidal influences
- Wind dynamics
- Wave dynamics, including wave height, run-up, and direction of impact
- Water currents that may be present or could result from a submerged structure
- Stability of a submerged structure, including deterioration from corrosion by seawater
- Shoreline slope stabilization
- Constructability
- Aesthetics, both overall and in terms of the nearby shoreline
- Environmental impacts of the shoreline and bay area
- Relative economics
- Operation and maintenance (O&M) requirements

Based on the need to protect the nearby shore, experience at other sites, and a literature review of various engineering techniques, three general categories of protection were investigated:

- **On-shore revetment**: this option involves riprap that covers and protects the shoreline, resting on specially designed geotextile filter fabric to prevent erosion of fine material while allowing transfer of water. In the case of IR Site 7, a revetment would extend to at least the IR Site 7 boundary to cover all confirmed shoreline contamination.
- **Hybrid living shoreline and breakwater**: this option would include regrading along the shoreline bank and planting native species along the shoreline to promote habitat restoration and reduce erosion. This option would include construction of an off-shore

breakwater to limit incoming wave energy to reduce erosion of the shoreline and protect the shoreline habitat from wave impact.

- **Above-shore sheet pile barrier**: this option is a solid wall of corrosion-resistant materials extending into the subsurface to prevent lateral contact with the contaminated soil on the land portion of the site. The sheet pile wall would as a secondary benefit provide erosion control of the land portion of the site in the event of a catastrophic loss of the existing shoreline.

Design criteria including the tidal influences, wind dynamics, and wave dynamics are uniform considerations for each design option and are not reiterated in this report. The DBR (ChaduxTt 2009b) presents details for these design criteria.

Given the available fetch distances and winds anticipated at the site (described in the DBR), waves of up to 4 to 5 feet could be anticipated in the vicinity of IR Site 7. Much of the energy of a wave of this size will have dissipated before it reaches the shore because of the gentle slope of the nearshore area at the site.

Protection of human and ecological receptors from exposure to shoreline sediment is a central concept for shoreline protection. Consequently, the design considers the future use of the site as a public park (San Francisco Redevelopment Agency 1997) and the potential for heavy foot traffic and vandalism. Each of the three shoreline protection options addresses potential exposure to COCs with varying degrees of protectiveness. Therefore, consistent O&M to maintain remedy integrity is an important consideration. Finally, development of the options considered the potential for sea level rise as a result of climate change (Church and others 2001 and 2008).

4.0 ANALYSIS OF OPTIONS

Using the design and selection criteria described above, and also summarized in the DBR, three shoreline protection options were developed. These options are, in general, similar to the shoreline protection options considered in the TMSRA during development of remedial alternatives. The primary objective of this technical memorandum was to investigate and compare the overall feasibility of each of the options in greater detail than was presented in the TMSRA. Care was taken in the investigation to assess as many factors as can be reasonably foreseen for each option described. However, some factors, especially in the costs, cannot be foreseen before the actual design process and communication with potential contractors and vendors. Consequently, costs are estimated in the range of +50 to -30 percent that is consistent with feasibility study-type estimates.

4.1 REVETMENT

A revetment is a facing of armor material such as stone or concrete that is intended to protect a shoreline feature from erosion or slope failure. The primary physical components of the revetment are the armoring material, the toe, the crest, and the filter layer (Figure 7). The armoring material is selected and sized based on the forces that will act against the structure, such as water currents, wave action, and gravity. The extent of the revetment, or the elevations of the toe and crest, is based on the expected high and low water conditions, significant wave heights, and wave run-up on the structure. The filter layer is set between the armoring material and the underlying soil or engineered fill and is intended to allow water to pass while supporting the armoring material and preventing erosion. Additional details of the design calculations for the revetment are included in the DBR.

The proposed revetment would be installed along the approximate 950 feet of shoreline where IR Site 7 meets the bay. A conservative approach to the conceptual design of the revetment was taken to maximize its ability to stabilize the shoreline and prevent contaminated soil from migrating to the bay. The procedures for the revetment design are based on the U.S. Army Corps of Engineers "Design of Coastal Revetments, Seawalls, and Bulkheads" and "Coastal Engineering Manual" (U.S. Army Corps of Engineers 1995 and 2006).

4.1.1 Revetment Design and Implementation Summary

The key components in the design of a revetment include the selection of suitable material, sizing of the selected material, selection of a slope for the structure, and determination of the overall dimensions of the structure (crest elevation, depth, and lateral extent). Primary consideration is given to the anticipated wave energy (based on the winds and available fetch distances), the topography of the shoreline and nearshore area, and the future use of the surrounding area.

In the case of IR Site 7, a slope of 1V:4H was selected for the revetment based on the current bank conditions to limit the total amount of excavation and regrading that would be necessary. The selected 1V:4H slope, similar to what currently exists along the bank, is also appropriate for a site with potentially considerable foot traffic because it should be shallow enough to facilitate foot traffic and not pose a risk of falls.

An extension of the revetment toe will be necessary to cover the contaminated sediments up to the IR Site 7 boundary (Figure 8). The toe extension portion of the structure will follow the general slope of the bay floor (approximately 1V:10H to 1V:20H). Excavation of 3 to 4 feet below the existing grade of the bay floor will be necessary to ensure that the revetment material is set on an adequate foundation and to minimize overall filling of the bay. Over time, sediment may cover the extension of the toe approximately to the current existing grade.

The selection of the size of riprap is based on the anticipated wave energy and the future use of the area. The U.S. Army Corps of Engineers Coastal Engineering Research Center recommends a minimum stone size of 400 to 500 pounds on projects with a high degree of public access (U.S. Army Corps of Engineers 1985). Stones smaller than this size would be subject to shifting under foot traffic or could be stolen, which would compromise the strength of the revetment. This median size stone would correspond to a design wave of approximately 4 to 5 feet, which is larger than the most conservative anticipated wave. A median weight of approximately 600 pounds would be appropriate to achieve a minimum size stone weight of about 400 pounds. More details on stone sizing and gradation are included in the DBR.

The revetment would extend from a crest elevation of approximately +15 feet above mean sea level (msl) to a depth of approximately -4 feet msl. The crest elevation of +15 feet msl was selected based on the anticipated future grading of the land portion of the site, which would reach this elevation near the shoreline. The crest elevation of +15 feet msl provides sufficient protection, considering the highest anticipated tide, the largest expected wave, and potential rise in sea level caused by climate change. In this report, a potential rise in sea level of up to 3 feet over the next 100 years has been used as a conservative estimate (Church and others 2001, 2008).

The revetment option would require excavation of approximately 5,000 cubic yards of soil and sediment. Excavated materials will be staged, screened for radiological contamination, and any materials that exceed remediation goals for radionuclides in soil will be removed and disposed of off site at a low-level radioactive waste disposal facility. The remaining screened material that has met radiological remediation goals will be used as fill under the revetment where necessary or spread under the soil cover over the land portion of the site.

4.1.2 Advantages and Disadvantages of the Revetment Option

The following sections summarize the advantages and disadvantages of a revetment option. The list is not exhaustive, but provides sufficient information for comparison among the three options.

4.1.2.1 Advantages

Stabilize the shoreline. A revetment as described would effectively prevent erosion along the shoreline.

Complete coverage of contamination. The proposed revetment would extend to at least the boundary of IR Site 7 and would cover all contaminated sediment and prevent human and ecological contact.

Constructability. The materials, equipment, and expertise are readily available, and construction of the project would be anticipated to be relatively straightforward. Construction could occur from shore, and there would be sufficient time during outgoing and incoming tides to construct the farthest extents of the structure during dry low water conditions.

Proven effectiveness. Shoreline armoring and revetment projects have been used extensively and successfully in the San Francisco Bay, including other portions of the HPS. The shoreline at Candlestick State Park, which is located within a mile of Hunters Point, is stabilized by a revetment project. Additionally, the shoreline of the Point San Bruno Park (located 5 miles south of Hunters Point) is stabilized by a revetment. These other locations have similar wind and wave dynamics and other design criteria to IR Site 7.

Flexible. Riprap structures are flexible and can withstand excessive forces, including seismic, gravitational, or erosional forces, without failure. They are intended to settle over time, resulting in greater overall strength of the structure.

Easily repaired. In the event of failure along the structure, it can be easily repaired by setting additional armor stone directly on the structure. Repairs could be accomplished from shore during low tides with standard excavating equipment.

Allow access to the water. Given the proposed slope of the structure, access to the water from the land would not be hindered.

Withstand foot traffic. The revetment would be able to withstand the potentially significant foot traffic that could be expected under a public park scenario using the proposed stone weights. This foot traffic over the revetment could result from the influx of people to the site and usage of the shoreline.

Minimal O&M. Riprap revetments generally do not require excessive or costly O&M to sustain the structure.

4.1.2.2 Disadvantages

Elimination of the existing shoreline and beach. A revetment would essentially eliminate the beach and vegetation that currently exist along the shoreline at IR Site 7. Portions of the beach currently exist at slopes similar to the 1V:4H slope of the revetment. It is possible that some of these beach areas could be at least partially recovered by sediment carried by natural wave and current action. This portion of the bay is depositional (Barajas and Associates 2008) and some recovery will likely result; however, the revetment will change the near shore wave and current dynamics which will also affect deposition rates and the extent of recovery is unknown.

Excavation of contaminated sediment. The revetment option requires excavation of contaminated sediment along the shoreline. This material will be screened for radioactivity, and clean material would be used as a foundation below the revetment or beneath the cover on the land portion of IR Site 7. Screening the material and potential off-site disposal of contaminated sediment would increase the project cost.

Poor visual aesthetics. Revetments can be considered unsightly or unnatural-appearing structures.

Potentially disruptive of contamination. Care needs to be taken during construction to prevent migration of disturbed sediments in the intertidal zone. Appropriate mitigation measures will be required, such as working during low water conditions.

Potential undermining. The toe of the structure and the flanks could be vulnerable to undermining from wave and current forces. Special consideration of these areas is needed during design, construction, and O&M of the revetment. The potential for undermining the revetment is minimal if properly designed and maintained.

Cost. The overall capital costs of a revetment would be moderately expensive – less in initial cost to the hybrid living shoreline and breakwater option but more expensive than the above-shore sheet pile barrier. O&M costs for the option should be minimal.

4.2 HYBRID LIVING SHORELINE AND BREAKWATER OPTION

A hybrid living shoreline and submerged breakwater for the site would be based on the general concept of trying to maintain the coastline portion of IR Site 7 as a beach and promoting habitat for vegetation, both planted during the project and that may grow naturally. The vegetation of the living shoreline would provide erosion control over the shoreline area under most circumstances.

An off-shore breakwater structure would be necessary for this option based on the exposure of the IR Site 7 coastline to the San Francisco Bay toward the northeast. Living shoreline erosion control projects are not recommended for shorelines with fetch distances greater than 0.5 mile without offshore protection (Jefferson Patterson 2009). The longest fetch distances for IR Site 7 are approximately 6 miles to the north–northeast, as shown in Figure 9, which could result in the formation of 4- to 5-foot waves in the vicinity of site. The nearshore portion of the bay is gently sloped, and waves of this size would not likely reach shore before they break and dissipate most of their energy. However, waves would be anticipated during higher tides that could destroy shoreline vegetation if unprotected along a significant portion of IR Site 7.

Design of projects including living shorelines requires considerable time and study beyond the scope of this conceptual report, including sediment morphology and bioengineering. The following sections are intended to provide a conceptual basis of design and construction of the option.

4.2.1 Hybrid Design and Implementation Summary

The slope of the shoreline area is the primary consideration in the implementation of a living shoreline (Figures 10 and 11). Living shorelines require a gentle slope of not steeper than 1 vertical to 10 horizontal (1V:10H) in the intertidal zone to maintain vegetation (Center for Coastal Resources Management 2006). The current slope along the bank of the shoreline from msl to approximately 10 feet above msl varies between 1V:3H and 1V:8H, requiring significant regrading to achieve the prescribed slope requirements. Consequently, the top of the slope would be moved farther inland on the land portion of IR Site 7 beyond what currently exists. Approximately 6,000 cubic yards of soil would be relocated to achieve the prescribed slopes.

Of additional concern at IR Site 7 would be the contaminated sediments along the existing bank shoreline. Contaminated sediment has been confirmed along the shoreline to approximately the

IR Site 7 boundary. In addition to regrading the slope of the shoreline, this contaminated sediment would be removed and replaced with clean fill. Assuming 2 feet of sediment is removed, approximately 3,500 cubic yards of sediment would require excavating and backfilling with clean fill from an off-site borrow source in the intertidal zone. The excavated contaminated sediment would be screened and spread on the land portion of the site under the proposed cover or disposed of off site if necessary.

Offshore protection would be necessary to protect the shoreline and shoreline species from potential wave energy because of the open exposure of the area. The most appropriate protective structure would be an off-shore submerged breakwater composed of rock riprap (U.S. Army Corps of Engineers 1987 and 2006, and Linsley and Franzini 1979). The breakwater would be designed to prevent waves from reaching shore affecting the shoreline and vegetation. A breakwater can be located any distance from the shoreline. A distance of 100 feet from the bank was selected for this conceptual summary to minimize potential for obstruction of boat traffic. At this distance, the base of the structure would be submerged at all times below the water level, regardless of tide, to minimize the potential for undermining. At this proposed distance from shore, seaward-facing armor rocks would be approximately 1,000 pounds or greater, given the depth of water and wave energy anticipated.

Constructability is a major consideration in the location of a breakwater. The breakwater proposed in this report would have a crest elevation of approximately 4 feet above msl, which is approximately equal to the high tide elevation. This distance off shore and crest elevation would correspond to a structure approximately 25 feet wide with an overall height of 9 feet from the existing grade of the bay floor. The breakwater would have the potential to alter the local bay currents and affect local sediment deposition or erosion, and these effects are not predictable without additional study.

The bearing capacity of the off-shore sediment for supporting a breakwater is unknown. It is likely that the seabed material is highly compressible and could require dredging sediment and placing a geosynthetic material under the structure to provide an adequate foundation for its weight. Approximately 2,500 cubic yards of sediment was assumed to be dredged.

4.2.2 Advantages and Disadvantages of the Hybrid Option

The following sections summarize the advantages and disadvantages of a hybrid living shoreline and breakwater option.

4.2.2.1 Advantages

Shoreline habitat. The primary advantage to any project that incorporates a living shoreline is that it creates natural habitat and maintains a natural appearance of the coastline. This feature is particularly advantageous in developed coastal areas such as Hunters Point, where little natural shoreline habitat exists.

Off-shore habitat. Breakwaters and other off-shore structures provide habitat for fish, crustaceans, and other species that use the structure as protection from predators.

Access to the water. Given the gentle slopes that are needed for the shoreline, access to the water would be unimpeded from the landward portion of the site.

Natural regrowth. Natural continuing regrowth of vegetation along the shoreline should occur over time after the initial planting.

Visual aesthetic appeal. The living shoreline would be visually appealing for future users of the shoreline and the adjacent park.

Coverage of contamination. Much of the contaminated sediment would be excavated and placed on site under the proposed cover. Contaminated sediment would be covered to approximately the site boundary by clean fill and therefore would prevent human and ecological contact. Sediment associated with Parcel F would not be addressed.

4.2.2.2 Disadvantages

Not generally appropriate in this situation. Living shorelines are considered appropriate in situations where significant natural protection from wave exposure already exists and are typically not considered appropriate in areas of open shoreline with wave exposure (both natural and from boats), as is present at IR Site 7. A breakwater would reduce the wave exposure but would add significant cost and complexity to the project.

Existing steep slopes. The existing shoreline slopes would need to be regraded to accommodate vegetation. Regrading would cause a significant portion of IR Site 7 (approximately 1 acre) to become part of the sloped shoreline bank rather than the relatively flat upland that currently exists. Additionally, significant volumes of sediment and soil would need to be screened for contamination and disposed of off site or placed under the cover.

Unknown pathway to ecological receptors. Potential radionuclides in sediment pose an unknown risk pathway to ecological receptors through plant uptake. This potential would need to be assessed before the remedy could be implemented.

Difficulty initiating and maintaining growth. Planting on sloped land and in coastal zones can be challenging, especially if conditions are not optimal. Ongoing frequent maintenance of the area would be necessary to ensure that the vegetation is maintained and continues to provide adequate erosion control.

Insufficient erosion control. It is possible that vegetation would not provide sufficient erosion control to maintain the 2-foot-thick layer of clean fill along the proposed slopes, even with the offshore breakwater. If this cover is not adequately maintained, it could result in human exposure to contaminated sediments or a release of contamination to the bay.

Public access. The water would be accessible from shore; however, activities such as digging would need to be prevented to protect direct human contact with contaminated sediment. Additionally, excessive foot traffic and use of the area could hamper the growth of the vegetation that would be needed to provide erosion control and maintain the protective cover. The foot traffic itself could also initiate erosion along heavily traveled routes.

Construction of the breakwater. The breakwater would be constructed below the low tide water level and would require special equipment. A barge would likely be needed to stage materials and situate an excavator for construction. The location and dimensions of the breakwater can be changed from what has been proposed, but construction would most likely need to be completed from off shore under most scenarios.

Excavation of contaminated sediment. The hybrid option requires excavation of contaminated sediment along the shoreline. This material will be screened for radioactivity, and clean material could be used beneath the cover on the land portion of the site. Screening the material and potential off-site disposal add to the project cost.

Potentially disruptive of contamination. Care needs to be taken during construction to prevent migration of disturbed sediments in the intertidal zone. Appropriate mitigation measures would be needed.

Living shoreline O&M. The shoreline would need to be regularly inspected as well as inspected after storms to remain protective of human health and ecological receptors. There is also a high likelihood of the need for replanting, regrading, sediment replenishing, and other landscaping to maintain the cover and vegetation. A less-steep slope would reduce the erosion potential, but the slope would extend the shoreline farther into the existing upland portion of the site, which could limit future uses.

Breakwater O&M. The seaward-facing portion of the breakwater could be inspected only from the open water and would require a boat for access. Additionally, any repairs that may be needed, especially to the seaward side, would likely require specialized equipment and labor such as barge-mounted excavators.

Erosive forces. Breakwaters are subject to greater wave energy because of their location farther away from shore. Incoming waves have less time to dissipate before they contact the structure, and a breakwater would need to be able to withstand full wave impact at high tides. Currents, either existing or resulting from the newly placed structure, could undermine the structure.

Modification of existing bay conditions. Existing off-shore currents and sediment deposition patterns could be significantly affected by a breakwater, with potential off-site impacts to other coastal structures and shoreline. This impact is difficult to predict and mitigate.

Stability of the bay floor material. It is unknown whether the bay floor sediment material can support the weight of a breakwater. The off-shore material is likely soft and highly compressible; significant settling of the structure would be anticipated, together with the subsequent need for repair.

Boat traffic obstruction. Breakwaters pose an obstacle to boats traveling along shore, and they prevent easy access to the shore from the water.

Cost. The overall capital costs of the living shoreline and breakwater option would be the most expensive of the three. Additionally, O&M for the option would likely be extensive and costly, given the risk of exposure and off-site migration.

4.3 SHEET PILE BARRIER

A sheet pile barrier is a driven or excavated-and-placed retaining wall intended to prevent human and ecological contact laterally from the outward facing side of the structure. For IR Site 7, the barrier would also be constructed to secure and maintain in place the land portion of the contaminated soil in the event of a catastrophic loss of the shoreline. A primary consideration in the design of a sheet pile barrier for the site would be to allow easy access to the water from land and not alter the existing beach and vegetated areas along the shore. The barrier at the site would not be intended to prevent erosion of the shoreline or prevent migration of contaminated soil and sediment that exist along the shoreline.

The components of a sheet pile barrier are the sheet piles themselves, tie-backs, and anchors to further secure the barrier against movement and failure, and if necessary, protective gravel layers on either side of the barrier below grade to facilitate transport of water through the barrier (U.S. Army Corps of Engineers 1995 and 2006). The sheet piles are interlocking sections of material of uniform width that are set into place either individually or in sections. Selection of the sheet pile material is important to ensure that the barrier will withstand all gravitational and corrosive forces present in the subsurface.

4.3.1 Sheet Pile Barrier Design and Implementation Summary

An above-shore sheet pile barrier would be installed to a depth of approximately -5 feet msl, which is approximately 15 feet below the existing grade (Figures 12 and 13). This depth below the low tide water level would be sufficient to support the landward side of IR Site 7 if the shoreline or sections of the shoreline were completely lost after a storm or other event. The elevation of the top of the barrier would be based on the final cover grade over the upland portion of IR Site 7 and would not extend above the final cover grade.

The above-shore sheet pile barrier would be installed approximately 10 feet back from the break in slope down to the shoreline. This offset would allow sufficient distance to fill and grade the existing shoreline to meet with the final cover elevation of approximately +15 feet msl.

An appropriate sheet pile material and thickness would need to be selected based on prolonged exposure to salt water and the gravitational forces that would be present if the shoreline were eroded. Steel sheet piles have traditionally been used and are prevalent in the San Francisco Bay area, but there are also a variety of plastic and composite materials that could be appropriate. Tie-backs and anchors would also be selected based on the same considerations. Specific materials and configurations were not investigated during this conceptual study, but steel piles and standard configurations were assumed to be appropriate.

Sheet piles could be installed by driving or placing into an excavation. The individual sheet piles are driven into place when possible because it is the fastest and most cost-effective approach. Sections (usually about 1 to 1.5 feet wide) are driven or vibrated down into place one at a time along the alignment of the barrier. Feasibility of driving sheet piles depends on site soils and the sheet pile material. Soil that contains boulders or fill material that contains concrete or metal debris will prevent the sections from being driven. In these instances, excavation may be more appropriate. A trench is excavated to the desired depth, and the sheet piles are placed in the excavation and secured with gravel or some other permeable backfilled material. If excavation is necessary for placement of the barrier, approximately 2,000 cubic yards would have to be excavated. Previous excavation at the site has not encountered buried debris; however, concrete rubble is present along the shoreline.

Ordinarily, the type of sheet pile barrier described would be used as a bulkhead or sea wall and would be armored where exposed to prevent undermining the structure. In the case of IR Site 7, the above-shore sheet pile barrier would be designed and constructed so that it could function in this manner as a contingency if there were a loss of the shoreline to prevent migration of the upland contaminated soil to the bay. However; bayside soils are unprotected under this option and could be eroded, resulting in migrations of COCs to the bay.

4.3.2 Advantages and Disadvantages of the Sheet Pile Barrier Options

The following sections summarize the advantages and disadvantages of an above-shore sheet pile barrier option.

4.3.2.1 Advantages

Visual appeal. An above-shore sheet pile barrier project as described would be installed completely below grade and would be unnoticeable to users of the area in the future.

Easily constructed. The construction of a sheet pile barrier above shore would be relatively straightforward using either method of installation. There are many similar projects in the San Francisco Bay area.

No disruption of the existing beach. The current beach and shoreline would not be altered, maintaining existing conditions.

Unobstructed beach access. Access to the beach area would be unobstructed by the structure, similar to what currently exists at the site.

Minimal excavation. If the sheet piles could be driven, there would be no appreciable excavated material. In the event that excavation and placement of material were necessary, less than 2,000 cubic yards would be excavated.

Least disruptive to the current sediment conditions. A sheet pile barrier would be the least disruptive to the contaminated material along the shoreline. There would be no releases of contaminated sediments to the bay beyond what is already occurring.

Capital and O&M Cost. The above-shore sheet pile barrier would be the least expensive of the three options described. O&M is anticipated to be minimal.

4.3.2.2 Disadvantages

Does not address the shoreline. A sheet pile barrier as described is not intended to prevent shoreline erosion and would not address the portion of the site seaward of the barrier. COCs present along the shoreline portion of IR Site 7 would be subject to migration and would pose a human and ecological health risk.

Easy access to the beach. Although access to the beach would be unobstructed, the contamination along the shoreline poses a risk to human health. Access to the beach would need to be prevented through signage or fences until the contamination along the shoreline could be addressed under future projects.

Potential obsolescence. This remedial option does not secure the shoreline or prevent human contact with COCs along the shoreline. The shoreline contamination will need to be addressed at some point in the future and ultimate implementation of such a remedy would potentially render an above-shore sheet pile wall obsolete.

Risk of failure. A steel sheet pile barrier could be subject to corrosion over an extended length of time and could fail as a result, which would be difficult to monitor because of its subsurface location. This disadvantage would be a major consideration in selecting appropriate materials. Other materials, such as polycomposites, may also be appropriate to mitigate this concern.

5.0 COST COMPARISON

General costs were developed for each of the three shoreline protection options and are presented on the next page. These costs are intended to be comparative and do not fully reflect the final costs of the project. Some costs were assumed to be similar for each of the three options, such as design and permitting, and were not included in the estimates. Costs were obtained using RSMeans (RSMeans 2005 and 2006) and the cost estimates in the TMSRA (ChaduxTt 2007). O&M was not included in the estimate but could vary significantly among the options.

Comparison of Capital Costs

Description	Quantity	Unit	Unit Cost	Cost	Notes
			Revetment		
Description	**Quantity**	**Unit**	**Unit Cost**	**Cost**	**Notes**
Shoreline Preparation					
Clearing and Grubbing	3	ac	$6,395.00	$19,185.00	
Excavation	5,000	cy	$4.25	$21,250.00	
On-shore Rough Grading	140,000	sy	$0.98	$137,200.00	
Materials and Excavation					
Riprap	25,000	tons	$45.62	$1,140,500.00	
Geofabric	16 500	sy	$2.32	$38,280.00	
Crushed Stone Filter	2,000	cy	$40.50	$81,000.00	
Waste Hauling and Disposal					
Sampling	10	ea	$1,036.00	$10,360.00	
Haul	50	ea	$735.00	$36,750.00	Assume disposal of 20% of excavation and 20 cubic yards per load
Dump Charge	1,000	cy	$106.00	$106,000.00	
Truck Decontamination	50	ea	$158.00	$7,900.00	
				$1,600,000.00	**Approximate Capital Cost of Option**
			Hybrid Living Shoreline and Off-shore Breakwater		
Description	**Quantity**	**Unit**	**Unit Cost**	**Cost**	**Notes**
Shoreline Preparation					
Clearing and Grubbing	5	ac	$6,395.00	$31,975.00	
Excavation Along Bank and Off-shore	8,000	cy	$4.25	$34,000.00	
Rough Grading	200,000	sy	$0.98	$196,000.00	
Excavation of Intertidal Zone	3,500	cy	$6.38	$22,312.50	Assume additional unit cost due to tidal issues
Fill for Intertidal Zone	3,500	cy	$7.15	$25,025.00	Specialized fill for wetland (assumed approx cost)
Place and Compact	3,500	cy	$5.74	$20,090.00	
Demarcation/Geofabric	4,000	sy	$2.32	$9,280.00	
Waste Hauling and Disposal					
Sampling	20	ea	$1,036.00	$20,720.00	
Haul	115	ea	$735.00	$84,525.00	Assume disposal of 20% of excavation and 20 cubic yards per load
Dump Charge	2,300	cy	$106.00	$243,800.00	
Truck Decontamination	115	ea	$158.00	$18,170.00	
Shoreline Materials					
Planting Intertidal Zone	1.5	ac	$11,370.00	$17,055.00	
Upland and Bank Planting	3	ac	$3,790.00	$11,370.00	
Miscellaneous	4.5	ac	$7,580.00	$34,110.00	Fencing, irrigation, replanting, etc
Off-shore Preparation Breakwater					
Barge	2	mo	$3,363.00	$6,726.00	
Tug Boat	2	mo	$5,000.00	$10,000.00	
Dredging Mob and Demobilization	1	ea	$18,900.00	$18,900.00	
Dredging with Barge Mounted Clamshell	5,000	cy	$45.00	$225,000.00	
Off-shore Materials Breakwater					
Filter Fabric	2,000	sy	$2.32	$4,640.00	
Breakwater Rock	22,500	tons	$45.62	$1,026,450.00	
				$2,060,000.00	**Approximate Capital Cost of Option**
			Sheet Pile Barrier Wall		
Description	**Quantity**	**Unit**	**Unit Cost**	**Total Cost**	**Notes**
Shoreline Preparation					
Clearing and Grubbing	2	ac	$6,395.00	$12,790.00	
Excavation	2,000	bcy	$4.25	$8,500.00	
On-shore Rough Grading	5,000	sy	$0.98	$4,900.00	
Waste Hauling and Disposal					
Sampling	5	ea	$1,036.00	$5,180.00	
Haul	20	ea	$735.00	$14,700.00	Assume disposal of 20% of excavation and 20 cubic yards per load
Dump Charge	400	cy	$106.00	$42,400.00	
Truck Decontamination	20	ea	$158.00	$3,160.00	
Materials					
Piles	20,000	sf	$30.00	$600,000.00	
Fill	1,000	cy	$30.00	$30,000.00	
Waling	20%	pile cost	$600,000.00	$120,000.00	
Protective Cover	125	cy	$1,000.00	$125,000.00	
Tie Backs	40%	pile cost	$600,000.00	$240,000.00	
				$1,210,000.00	**Approximate Capital Cost of Option**

Based on the approximate projected capital costs for the three options, the above-shore sheet pile barrier would be the least expensive and the hybrid option would be the most expensive. It is likely that O&M costs for the hybrid option would be considerably greater than the other two options. The hybrid option would require frequent inspections and would be subject to considerable shoreline erosion, necessitating placement of additional fill and vegetation throughout the life of the project. Additionally, any repairs to the breakwater could be difficult to complete.

6.0 CONCLUSION

Each of the three proposed options for the protection of the shoreline has advantages and disadvantages. The primary criteria that should be used to compare any shoreline remedies are their ability to prevent risk to human health and ecological receptors from COCs and prevent off-site migration of the shoreline COCs. Secondary consideration can be given to promoting natural habitat, the intrusiveness of the remedy, and associated costs among the options. The following summarizes the major advantages and disadvantages of the three options.

Summary of Shoreline Remedy Options Advantages and Disadvantages

		Proposed Option		
		Revetment	**Living shoreline and breakwater**	**Sheet pile barrier**
Primary Considerations	**Protective to receptors**	Most effective – large immobile physical barrier to contact	Effective with limitations – protective cover subject to erosion	Least effective – shoreline contamination left uncovered and in place
	Long-term effectiveness	Most effective -	Effective with limitations – effectiveness would depend on long-term maintenance which could be extensive and costly	Least effective -
	Prevents off-site migration of contaminants	Most effective – all contamination would be contained	Effective with limitations – protective cover subject to erosion	Least effective – shoreline contamination not addressed by remedy
Secondary Considerations	**Promotes natural habitat**	Least effective – Existing habitat would be covered with little chance of regeneration	Most Effective – regrading and planting would be conducted specifically for habitat	Effective – the existing shoreline and beach would not be affected
	Potential O&M costs	Minimal – revetments generally do not have long term problems	Greatest potential – both the shoreline and the breakwater have a high potential for failure	Minimal –generally do not have long term problems
	Intrusiveness	Intrusive – visually intrusive	Intrusive –benefits of the living shoreline would be offset by the off-shore breakwater	No intrusion – the sheet pile barrier would be unnoticeable
	Cost	Moderately costly	Most costly – potential O&M costs would significantly increase the overall projects costs	Least costly

Note: The most effective option for each consideration has been shaded gray. In the case of O&M, O&M tasks and costs for both the revetment and the sheet pile barrier would be similar.

Based on the above criteria, the revetment meets all the primary remedial objectives for overall effectiveness; the others do not.

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FIGURES

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FIGURE 1
HUNTERS POINT SHIPYARD
LOCATION MAP

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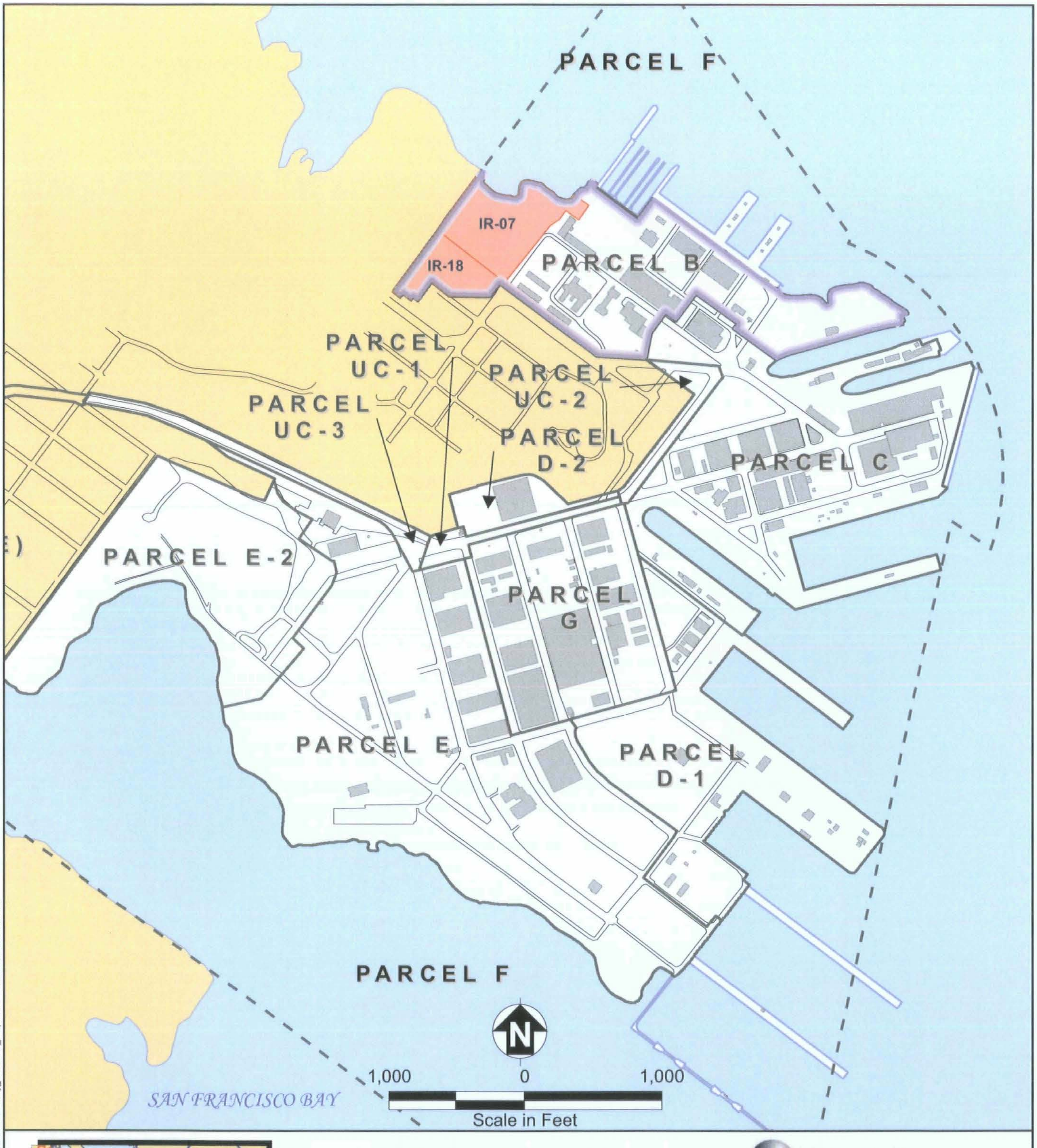

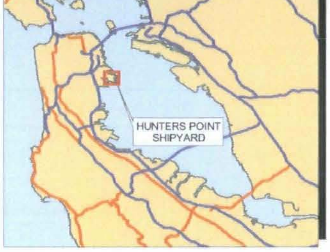

Location Map

- Installation Restoration Sites 7 and 18
- Parcel B Boundary
- Parcel Boundary
- Parcel F Boundary
- Building
- Non-Navy Property
- Road

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FIGURE 2
FACILITY LOCATION MAP

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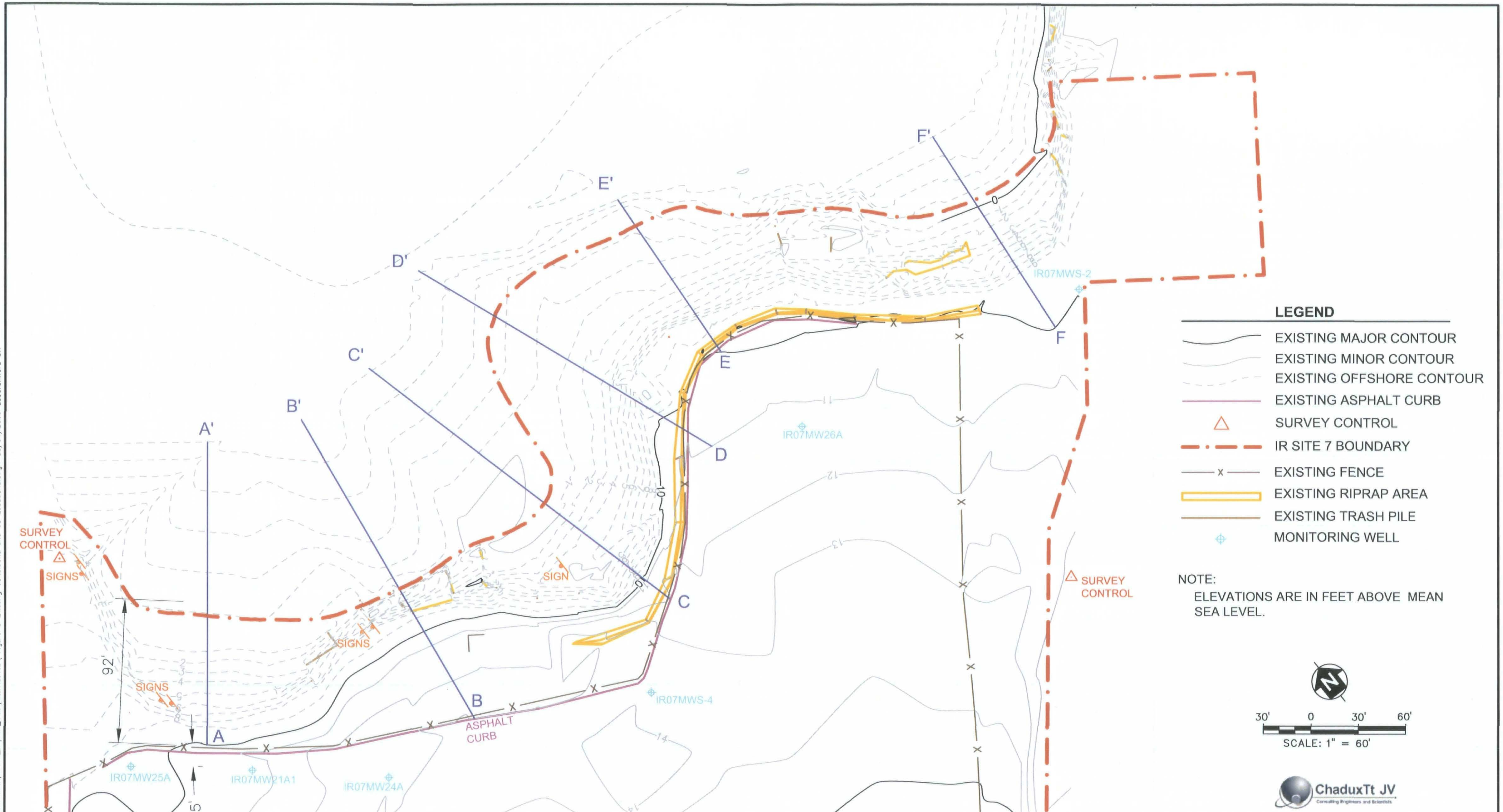

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FIGURE 3
EXISTING BANK TOPOGRAPHY AND CROSS SECTION LOCATIONS

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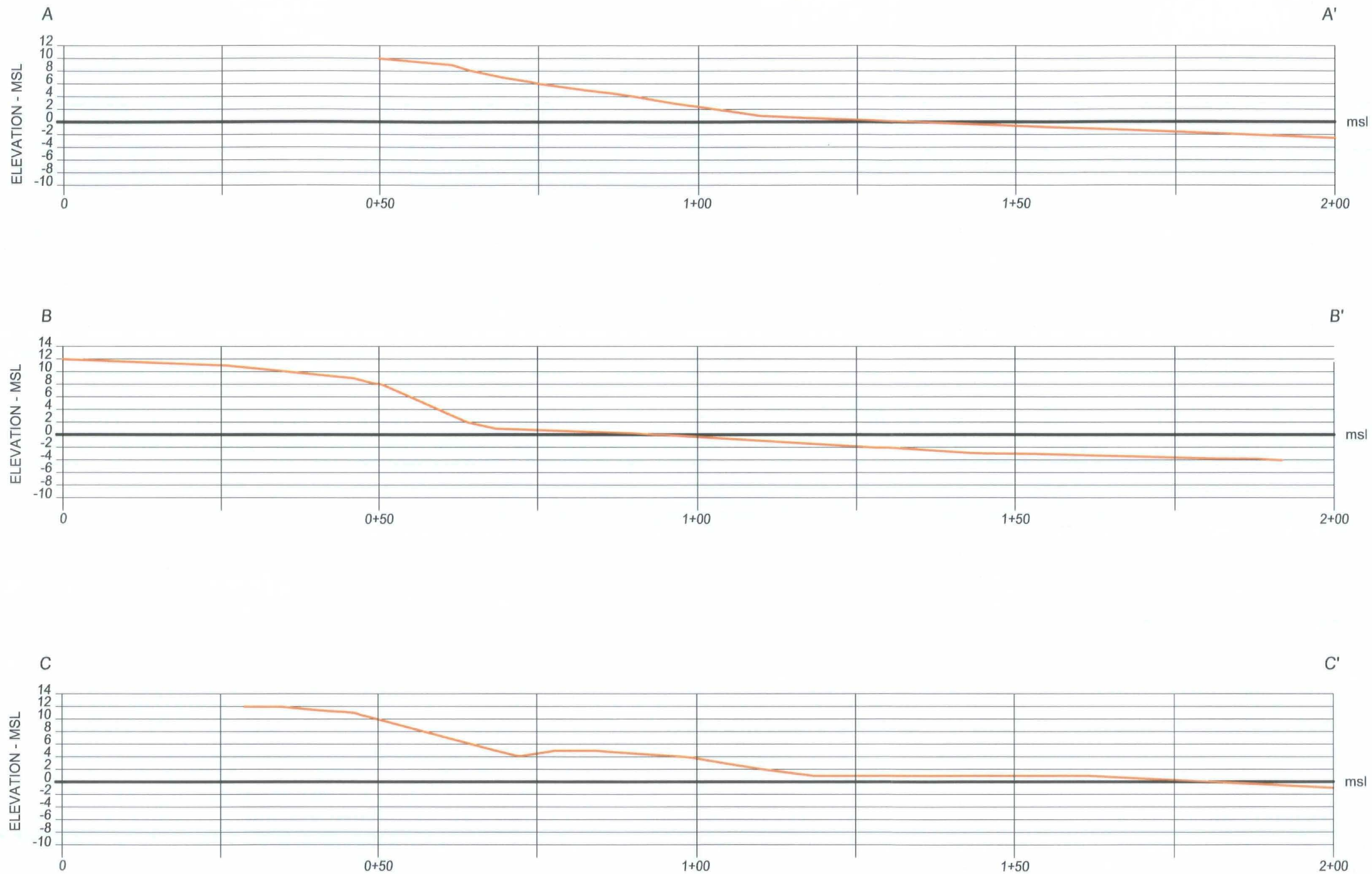
O:\Hunters_Point\...\Site_Features\Parcel_B\Ir07_Ir08\Alternatives\ Figure 3 Existing Conditions and CS Locations.dwg 03/31/2009 deborah.ford DN



LEGEND

EXISTING SURFACE

MEAN SEA LEVEL (msl)

NOTE:
ELEVATIONS ARE IN FEET MEAN SEA LEVEL.

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10' 0 10' 20'
SCALE: 1" = 20'

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FIGURE 4
BANK CROSS SECTIONS
A, B, AND C

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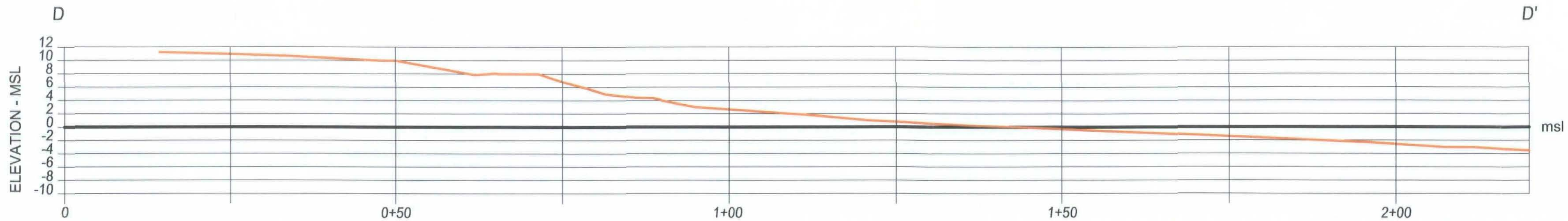

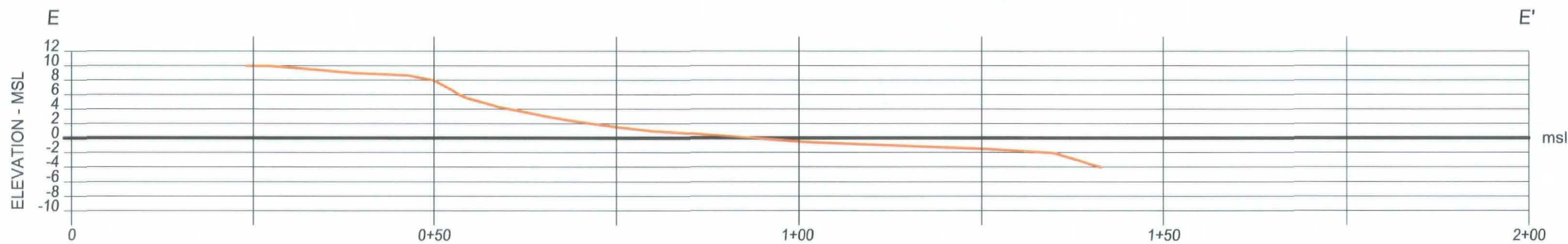

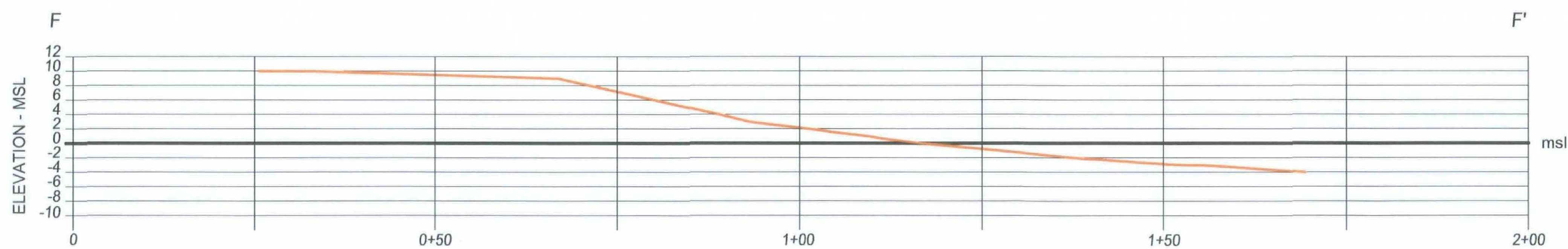

LEGEND

EXISTING SURFACE

MEAN SEA LEVEL

NOTE:
ELEVATIONS ARE IN FEET MEAN SEA LEVEL.

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10' 0 10' 20'
SCALE: 1" = 20'

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FIGURE 5
BANK CROSS SECTIONS
D, E, AND F

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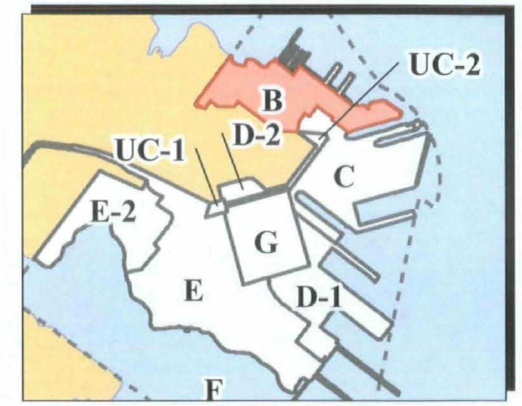

Location Map

- Chemical concentrations exceed remediation goals for human health and ecological receptors
- Chemical concentrations exceed remediation goals for ecological receptors
- Chemical concentrations do not exceed remediation goals
- IR Site 7
- Parcel B Boundary

Notes:

1. Aerial Photograph from July 24, 2008.

IR Installation Restoration

N

0 60 120

Scale in Feet

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FIGURE 6
CHEMICAL CONCENTRATIONS SUMMARY

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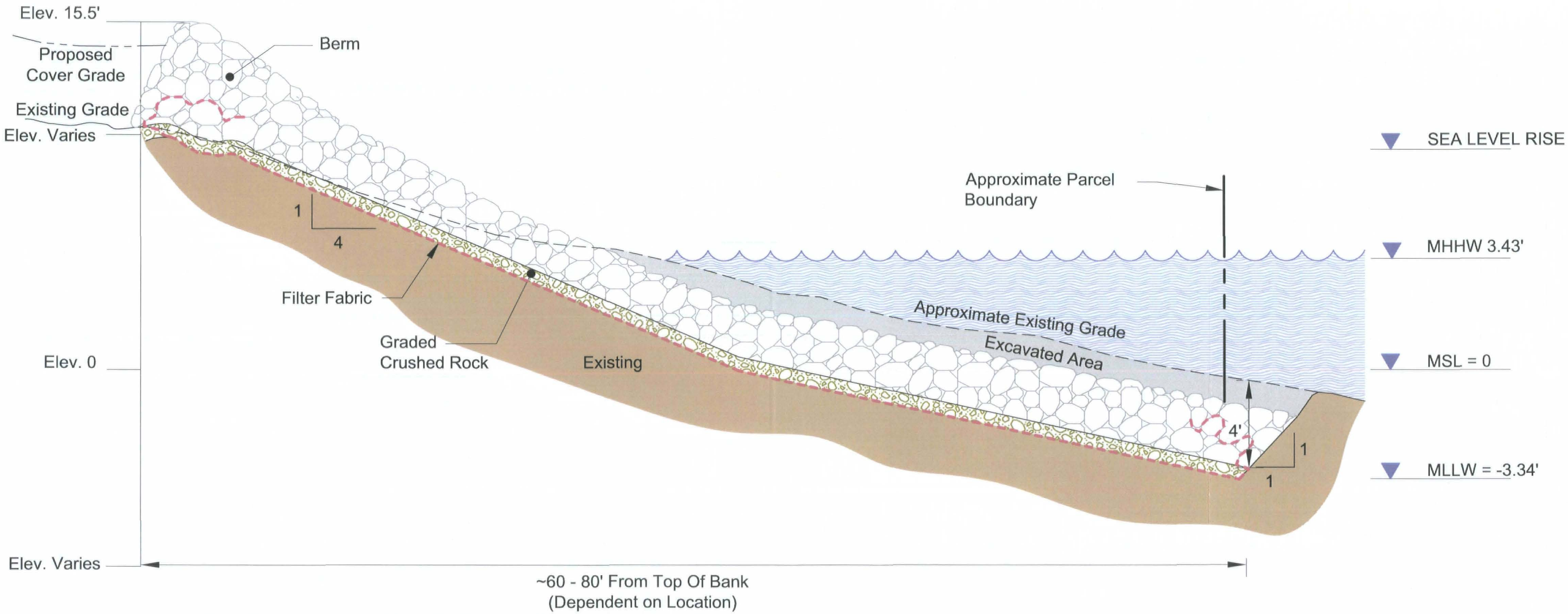

LEGEND

RIPRAP			APPROXIMATE PARCEL BOUNDARY
GRADED CRUSHED ROCK			APPROXIMATE EXISTING GRADE
EXISTING MATERIAL		Elev.	ELEVATION
SAN FRANCISCO BAY		MSL	MEAN SEA LEVEL
EXCAVATED GRADE		MHHW	MEAN HIGHER HIGH WATER
FILTER FABRIC		MLLW	MEAN LOWER LOW WATER

NOTE:
ELEVATIONS ARE IN FEET ABOVE MEAN SEA LEVEL.

NOT TO SCALE

DRAFT
NOT FOR CONSTRUCTION

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FIGURE 7
TYPICAL REVETMENT CROSS SECTION

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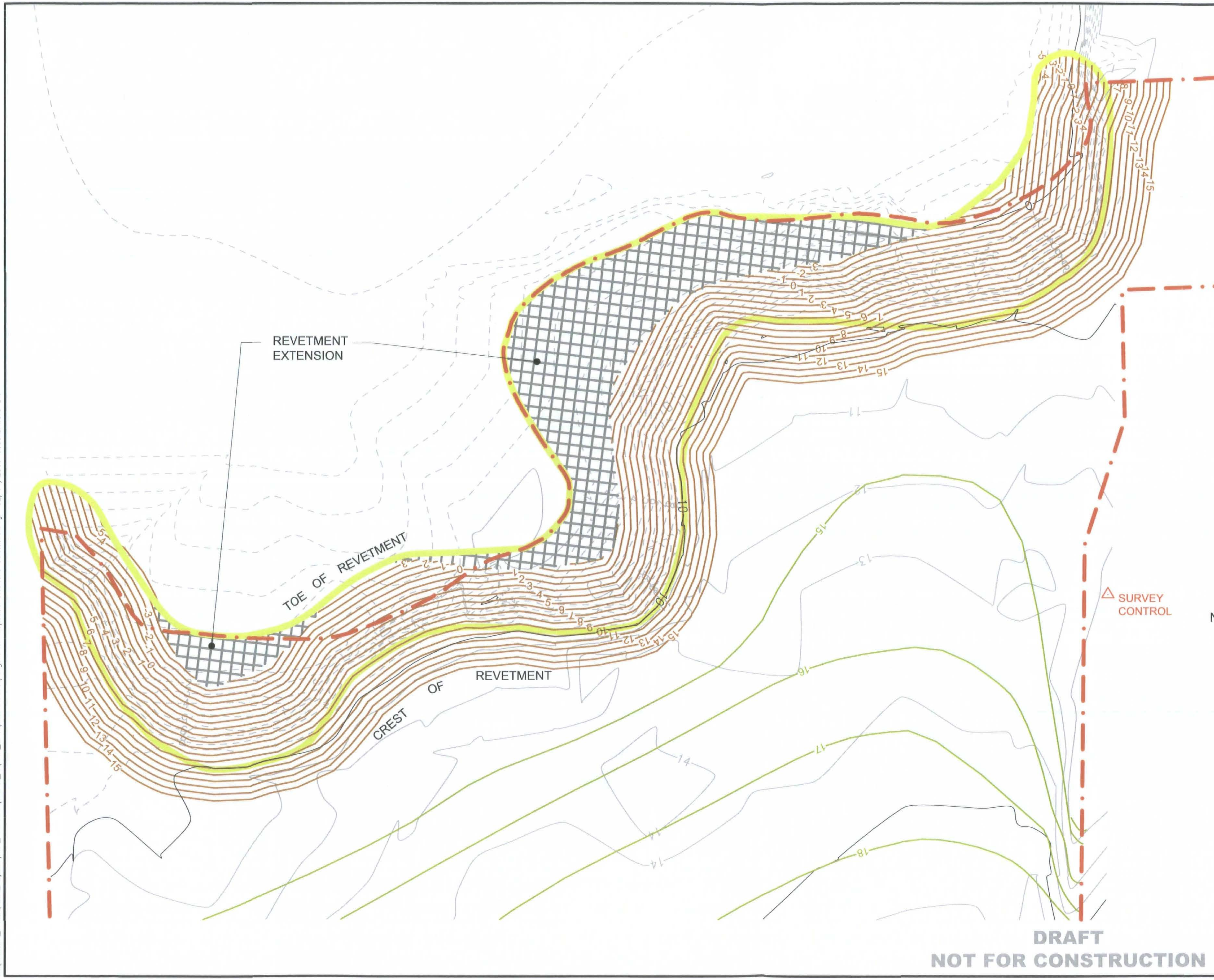

NOTE:
ELEVATIONS ARE IN FEET ABOVE MEAN SEA LEVEL.

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FIGURE 8
PROPOSED REVETMENT GRADE

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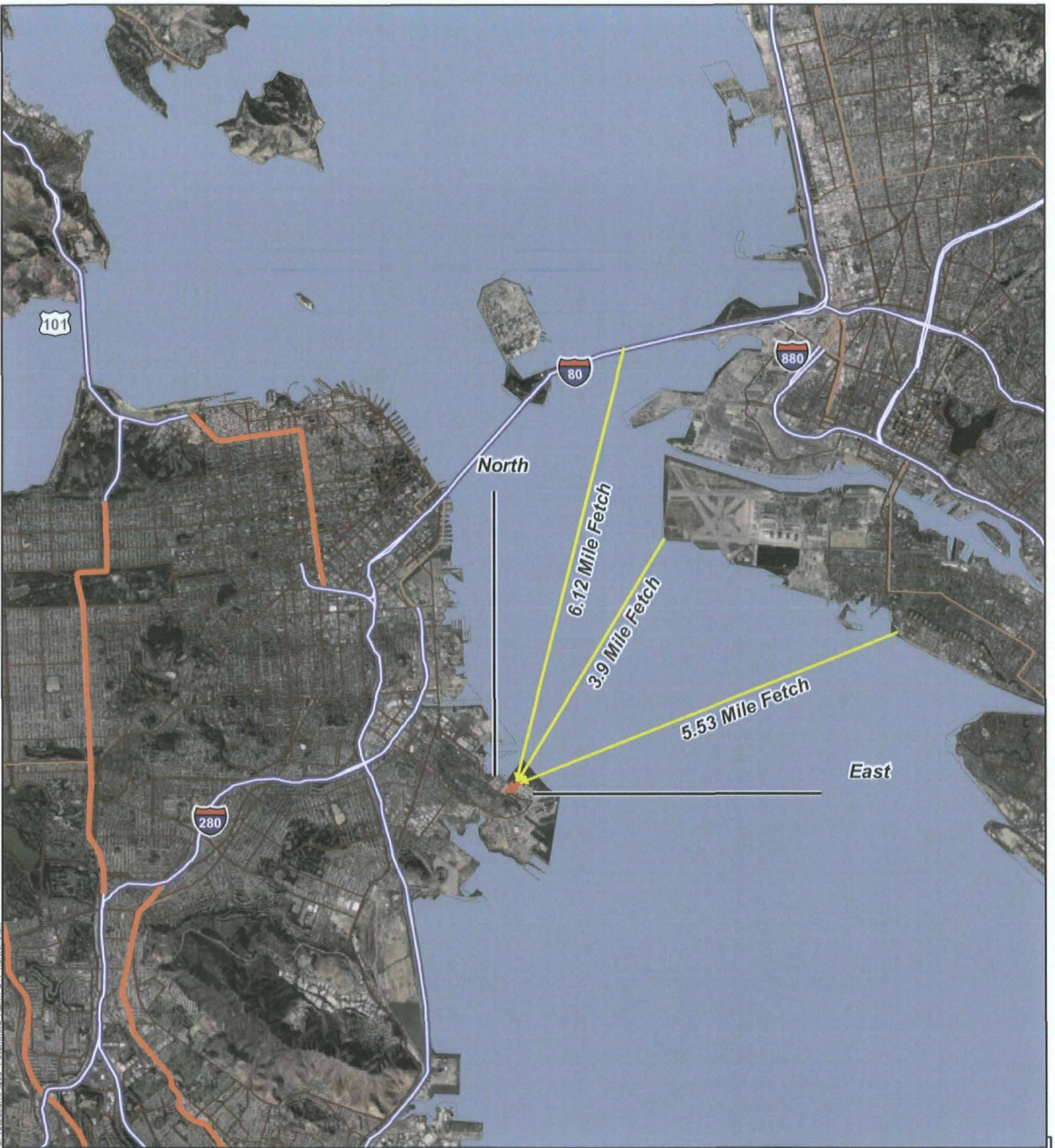
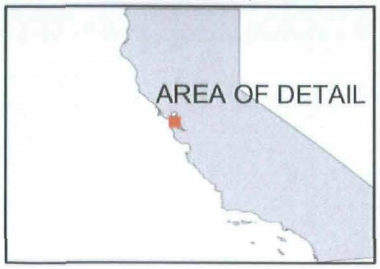


Location Map



N

1 0.5 0 1
Miles

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FIGURE 9
FETCH DISTANCES

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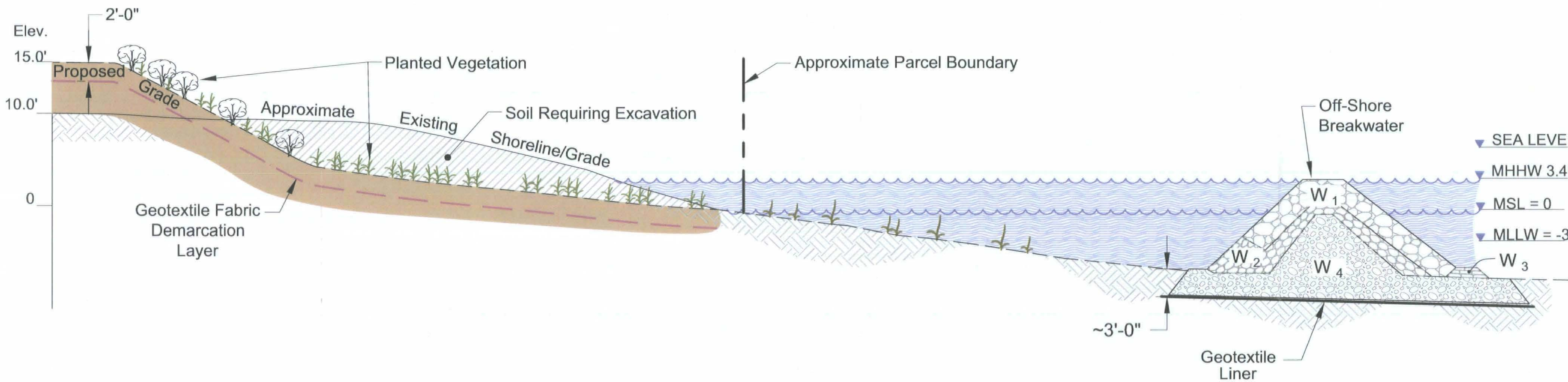

LEGEND

W_1	PRIMARY ARMOR STONE	— — —	APPROXIMATE PROPOSED GRADE
W_2	UNDERLAY STONE	Elev.	ELEVATION
W_3	TOE BERM ARMOR STONE	MSL	MEAN SEA LEVEL
W_4	CORE AND BEDDING STONE	MHHW	MEAN HIGHER HIGH WATER
	SAN FRANCISCO BAY	MLLW	MEAN LOWER LOW WATER
	IMPORTED FILL		

NOTE:
ELEVATIONS ARE IN FEET ABOVE MEAN SEA LEVEL.

NOT TO SCALE

DRAFT
NOT FOR CONSTRUCTION

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Department of the Navy, BRAC PMO West, San Diego, California

FIGURE 10
LIVING SHORELINE AND OFF-SHORE BREAKWATER CROSS SECTION

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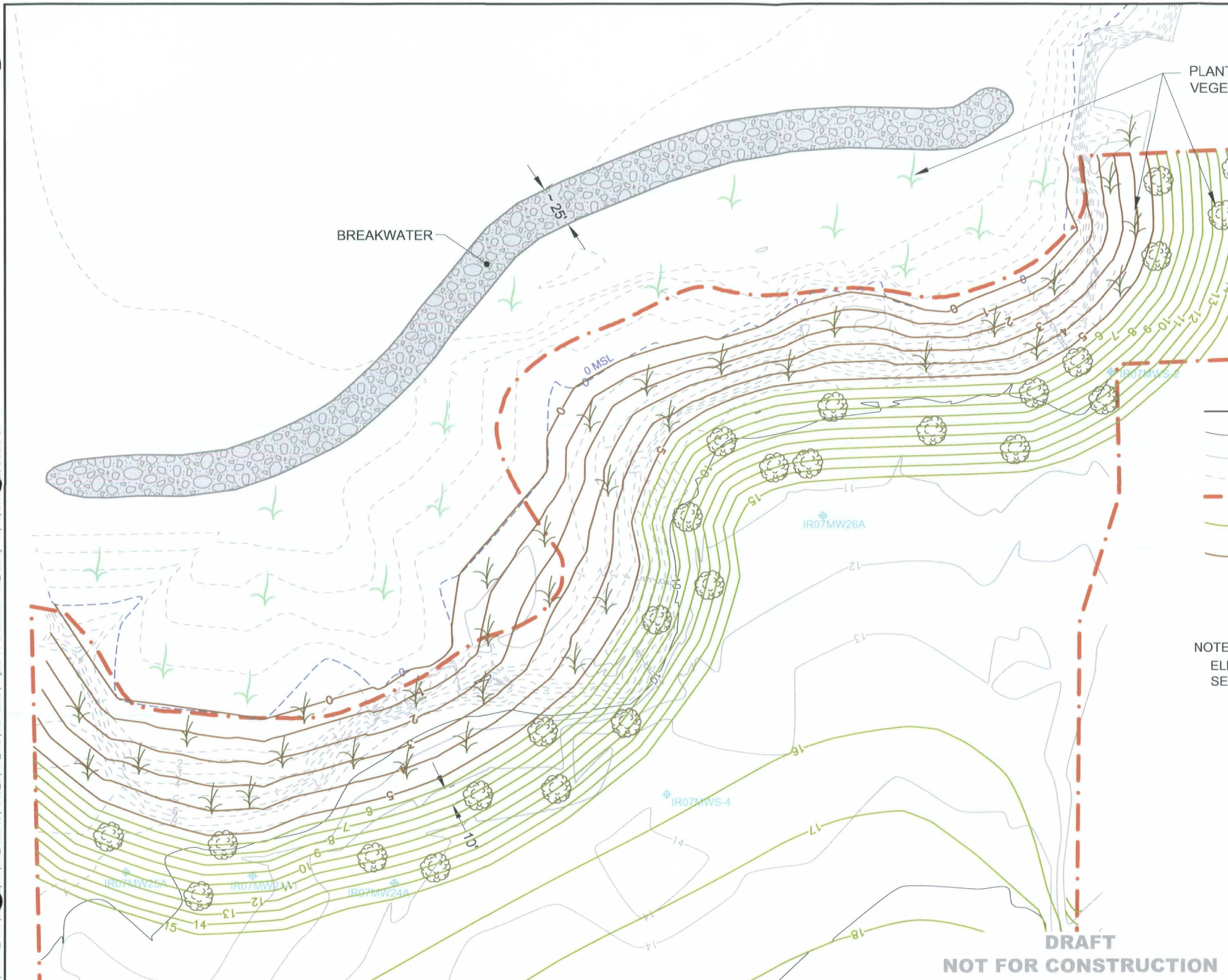

LEGEND

EXISTING MAJOR CONTOUR
EXISTING MINOR CONTOUR
EXISTING OFFSHORE CONTOUR
IR SITE 7 BOUNDARY
PROPOSED COVER CONTOUR
PROPOSED SHORELINE CONTOUR
MONITORING WELL

NOTE:
ELEVATIONS ARE IN FEET ABOVE MEAN SEA LEVEL.

30' 0 30' 60'
SCALE: 1" = 60'

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FIGURE 11
PROPOSED CONTOURS LIVING SHORELINE AND BREAKWATER

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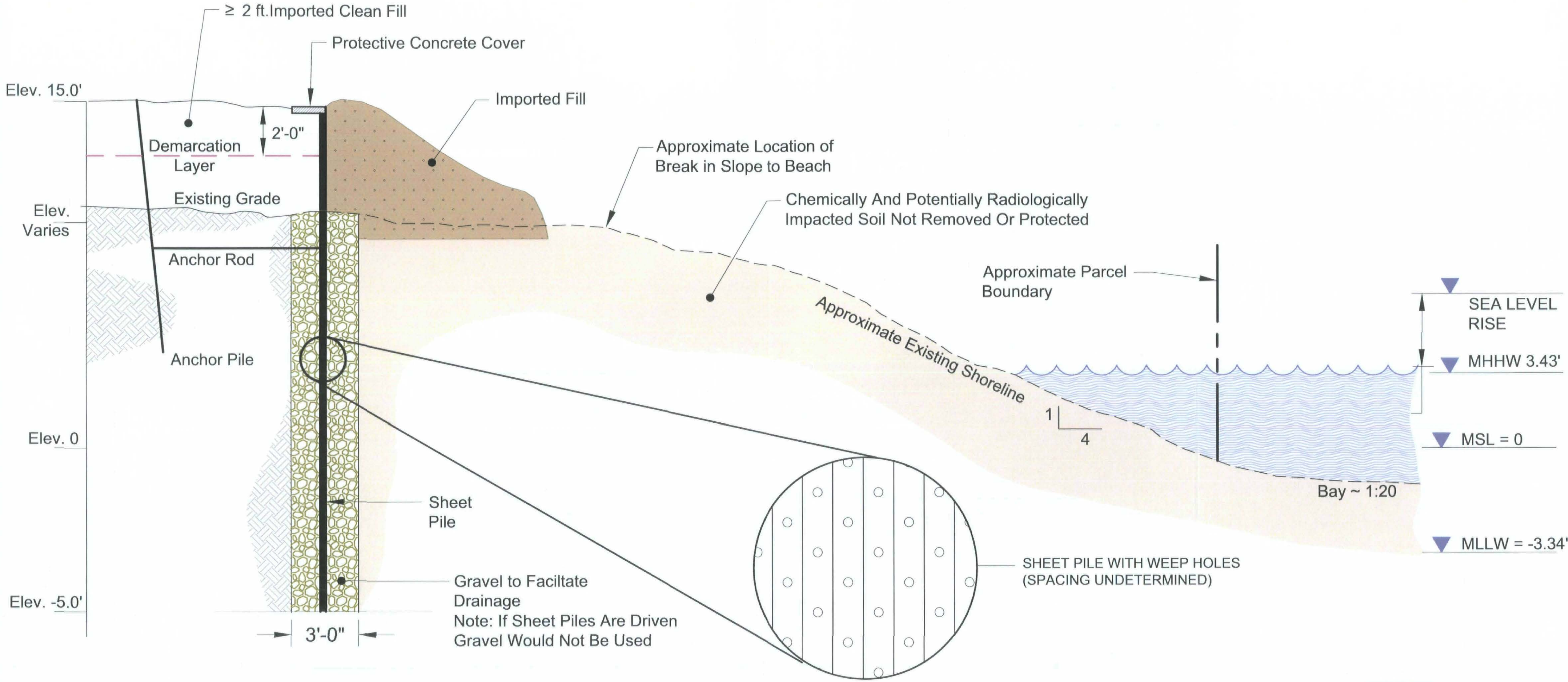

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LEGEND

	RIPRAP	Elev.	ELEVATION
	GRAVEL	MSL	MEAN SEA LEVEL
	SAN FRANCISCO BAY	MHHW	MEAN HIGHER HIGH WATER
— — —	APPROXIMATE EXISTING GRADE	MLLW	MEAN LOWER LOW WATER

NOTE:
ELEVATIONS ARE IN FEET ABOVE MEAN SEA LEVEL.

NOT TO SCALE

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FIGURE 12
SHEET PILE BARRIER CROSS SECTION

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FIGURE 13

PROPOSED SHEET PILE BARRIER CONTOURS

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